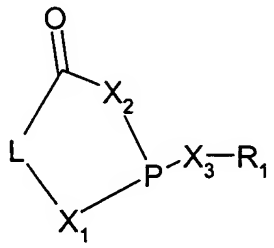
CLAIMS

1. Process for hydrocyanating a hydrocarbon-based compound containing at least one ethylenic unsaturation by reaction in a liquid medium with hydrogen cyanide in the presence of a catalyst comprising a metallic element chosen from transition metals and an organophosphorus ligand, characterized in that the organophosphorus ligand corresponds to general formula (I) below:



in which:

- X_1 and X_2, which may be identical or different, represent an oxygen atom or the divalent radical NR2, in which R2 represents a hydrogen atom or an alkyl, aryl, sulphonyl, cycloalkyl or carbonyl radical,
- X_3 represents a covalent bond, an oxygen atom or the divalent radical NR2, in which R2 represents a hydrogen atom or an alkyl, aryl, sulphonyl, cycloalkyl or carbonyl radical,
- the radical R_1 represents a linear or branched alkyl radical having from 1 to 12 carbon atoms that may contain hetero atoms, or a substituted or unsubstituted aromatic or cycloaliphatic radical that may contain hetero atoms or one or more rings in fused or nonfused form,
- L represents a linear or branched divalent alkyl radical having from 1 to 12 carbon atoms that may contain hetero atoms, or a substituted or unsubstituted aromatic or cycloaliphatic divalent radical that may contain hetero atoms and one or

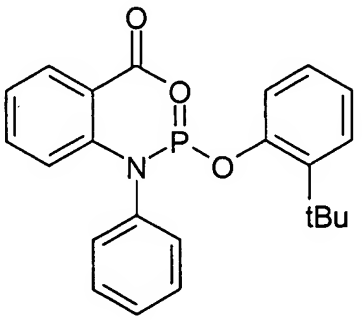
more rings in fused or nonfused form.

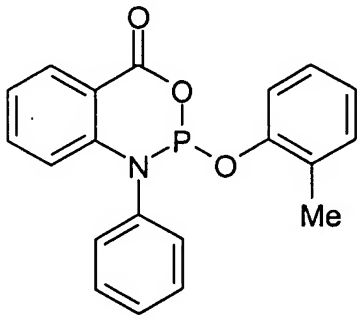
2. Process according to Claim 1, characterized in that X_1 and X_2 are different and represent equally an oxygen atom or a divalent radical NR2.

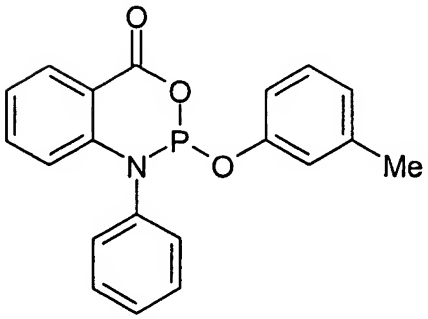
3. Process according to either of the preceding claims, characterized in that X_3 represents an oxygen atom.

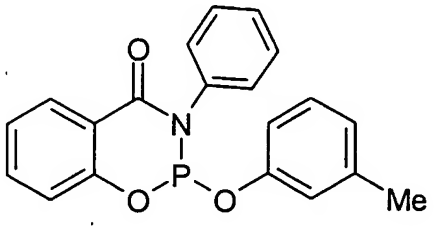
4. Process according to one of the preceding claims, characterized in that L represents an aromatic or cyclic divalent radical for which the bonds are in the ortho-position or an alkyl radical for which the bonds are borne by the same carbon.

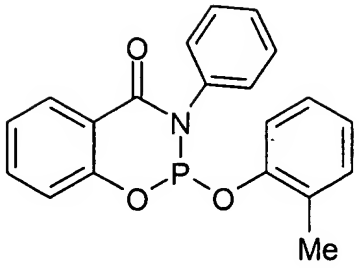
5. Process according to one of the preceding claims, characterized in that the compounds of general formula (I) are chosen from the group comprising the compounds of formulae below:

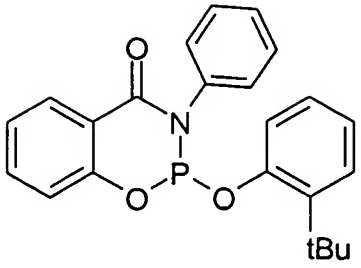


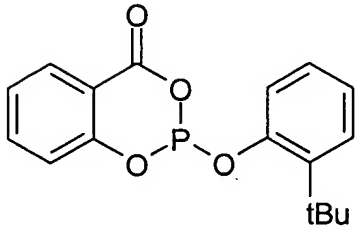












6. Process according to one of the preceding claims, characterized in that the metal element is chosen from the group comprising nickel, cobalt, iron, ruthenium, rhodium, palladium, osmium, iridium, platinum, copper, silver, gold, zinc, cadmium and mercury.

7. Process according to one of the preceding claims, characterized in that the reaction is carried out in a single-phase medium.

8. Process according to one of the preceding claims, characterized in that the catalyst corresponds to general formula (V):

$$M[L_f]_t \qquad (V)$$

in which:

M is a transition metal,

L_f represents the organophosphorus ligand of formula (I), and

t represents a number between 1 and 6 (limits inclusive).

9. Process according to one of the preceding claims, characterized in that the reaction medium comprises a solvent for the catalyst that is miscible with the

phase comprising the compound to be hydrocyanated, at the hydrocyanation temperature.

10. Process according to one of the preceding claims, characterized in that the compounds of transition metals are those of nickel and are chosen from the group comprising:

- compounds in which nickel is in oxidation state zero, such as potassium tetracyanonickelate $K_4[Ni(CN)_4]$, bis(acrylonitrile)nickel zero, bis(cycloocta-1,5-diene)nickel and derivatives containing ligands, such as tetrakis(triphenylphosphine)nickel zero;

- compounds of nickel such as carboxylates, carbonate, bicarbonate, borate, bromide, chloride, citrate, thiocyanate, cyanide, formate, hydroxide, hydrophosphite, phosphite, phosphate and derivatives, iodide, nitrate, sulphate, sulphite, aryl- and alkylsulphonates.

11. Process according to one of the preceding claims, characterized in that the organic compounds containing at least one ethylenic double bond are chosen from diolefins such as butadiene, isoprene, hexa-1,5-diene, cycloocta-1,5-diene, ethylenically unsaturated aliphatic nitriles, particularly linear pentenenitriles such as 3-pentenenitrile or 4-pentenenitrile, monoolefins such as styrene, methylstyrene, vinylnaphthalene, cyclohexene, methylcyclohexene, and mixtures of several of these compounds.

12. Process according to one of the preceding claims, characterized in that the amount of compound of nickel or of another transition metal used is chosen such that there is, per mole of organic compound to be hydrocyanated or isomerized, between 10^{-4} and 1 mol of nickel or of the other transition metal used, and in

that the amount of compounds of formula (I) or formula (II) used is chosen such that the number of moles of this compound, relative to 1 mol of transition metal, is from 0.5 to 500.

13. Process according to one of the preceding claims, characterized in that the hydrocyanation reaction is carried out at a temperature of 10°C to 200°C.

14. Process according to one of the preceding claims, for hydrocyanating ethylenically unsaturated nitrile compounds to dinitriles, by reaction with hydrogen cyanide, characterized in that the procedure is carried out in the presence of a catalyst system comprising at least one transition metal compound, at least one compound of formula (I) and a cocatalyst consisting of at least one Lewis acid.

15. Process according to Claim 14, characterized in that the ethylenically unsaturated nitrile compounds are chosen from ethylenically unsaturated aliphatic nitriles comprising linear pentene nitriles such as 3-pentenenitrile, 4-pentenenitrile, and mixtures thereof.

16. Process according to Claim 15, characterized in that the linear pentenenitriles contain amounts of other compounds chosen from the group comprising 2-methyl-3-butenenitrile, 2-methyl-2-butenenitrile, 2-pentenenitrile, valeronitrile, adiponitrile, 2-methylglutaronitrile, 2-ethylsuccinonitrile or butadiene.

17. Process according to one of Claims 14 to 16, characterized in that the Lewis acid used as cocatalyst is chosen from the compounds of elements of groups Ib, IIb, IIIa, IIIb, IVa, IVb, Va, Vb, VIb, VIIb and VIII of the Periodic Table of Elements.

18. Process according to one of Claims 14 to 17, characterized in that the Lewis acid is chosen from salts chosen from the group of halides, sulphates, sulphonates, haloalkylsulphonates, perhaloalkylsulphonates, haloalkylacetates, perhaloalkylacetates, carboxylates and phosphates.

19. Process according to one of Claims 14 to 18, characterized in that the Lewis acid is chosen from zinc chloride, zinc bromide, zinc iodide, manganese chloride, manganese bromide, cadmium chloride, cadmium bromide, stannous chloride, stannous bromide, stannous sulphate, stannous tartrate, indium trifluoromethylsulphonate, indium trifluoromethyl acetate, the chlorides or bromides of rare earth elements such as lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, hafnium, erbium, thallium, ytterbium and lutetium, and cobalt chloride, ferrous chloride and yttrium chloride and mixtures thereof, and organometallic compounds.

20. Process according to one of Claims 14 to 19, characterized in that the Lewis acid used represents from 0.01 to 50 mol per mole of transition metal compound.

21. Process according to one of Claims 1 to 20, characterized in that the isomerization of 2-methyl-3-butenenitrile, present in the reaction mixture originating from the hydrocyanation of butadiene, to pentenenitriles is carried out, in the absence of hydrogen cyanide, by working in the presence of a catalyst comprising at least one compound of formula (I) and at least one transition metal compound.

22. Process according to Claim 21, characterized in that the 2-methyl-3-butenenitrile subjected to the isomerization is used alone or as a mixture with 2-methyl-2-butenenitrile, 4-pentenenitrile, 3-pentene-

nitrile, 2-pentenenitrile, butadiene, adiponitrile, 2-methylglutaronitrile, 2-ethylsuccinonitrile or valeronitrile.

23. Process according to either of Claims 21 and 22, characterized in that the isomerization reaction is carried out at a temperature of 10°C to 200°C.

24. Process according to one of Claims 21 to 23, characterized in that the isomerization of the 2-methyl-3-butenenitrile to pentenenitriles is carried out in the presence of at least one transition metal compound and of at least one organophosphorus compound of formula (I).